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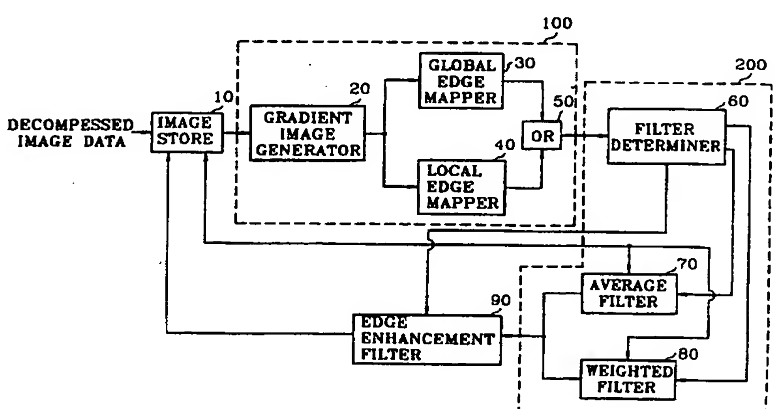
(54) Signal adaptive postprocessing system for reducing blocking effects and ringing noise

(57) A signal adaptive filtering method is provided to reduce blocking effects caused by decompression of the block-based compressed images, including the steps of generating binary edge map information by globally thresholding and locally thresholding the decompressed image; judging whether the binary edge map information within a filter window corresponding to respective pixels is either homogeneous area or edge area, by using the binary edge map information belonging to a predetermined size of the filter window; generating a filtered pixel value corresponding to a respective pixel using the filter window which has a predetermined first weight factors related to the homogeneous area, when the binary edge map information is judged as the homogeneous area in the second step; altering the predetermined second weight factors according to a binary edge map information included in the filter window when the binary edge map information is judged as the edge area in the second step; and generating a filtered pixel value corresponding to the respective pixel, using the filter window which has altered second weight factors in said fourth step. A corresponding apparatus is also disclosed.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 96 30 6904

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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X	US 5 359 676 A (FAN ZHIGANG) 25 October 1994 (1994-10-25)	1,5, 18-20	
A	* column 10, line 27 - line 60 * * abstract *	2-4,6-17	
X	EP 0 577 350 A (MATSUSHITA ELECTRIC IND CO LTD) 5 January 1994 (1994-01-05) * abstract *	18-20	
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A	EP 0 666 695 A (AT & T CORP) 9 August 1995 (1995-08-09) * abstract * * page 5, line 31 - line 41 * * figures 2,4 *	1-20	H04N
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 November 1999	Berbain, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 96 30 6904

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The members are as contained in the European Patent Office EDP file on
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04-11-1999

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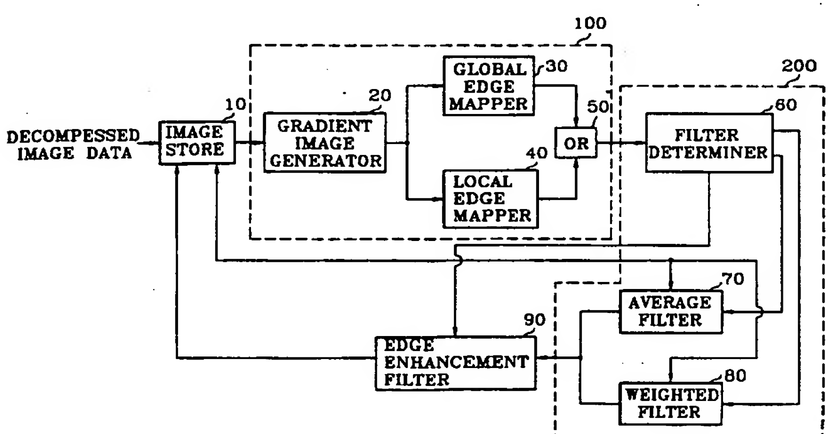
FIG. 1



EP 0 797 349 A2

Description

The present invention relates to a signal adaptive postprocessing system for reducing blocking effects and ringing noise, and more particularly, though not exclusively, to a system for adaptively attenuating blocking effects and ringing noise appearing at a decompressed image when highly efficient compressed image data is decompressed.

Most of picture coding standards including H.263 of International Telecommunication Union (ITU) and MPEG-1 and MPEG-2 of Organization for Standardization (ISO), use the block-based processing for motion estimation and discrete cosine transform (DCT). This block-based processing induces the well-known blocking effects and the ringing noise, in particular, when an image is highly compressed. The typical blocking effects are the grid noise in the monotone area and the staircase noise along the image edges. The blocking effects induce a viewer who views a decompressed image displayed on a screen to feel the boundary between the blocks in the visual sense. The ringing noise induces sinusoidal traces on the practical edges of an image.

It is an aim of preferred embodiments of the present invention to provide a method for largely reducing blocking effects and ringing noise caused by a decompressed image by adaptively filtering decompressed image data according to edges obtained from the decompressed image.

According to the present invention in a first aspect, there is provided a signal adaptive filtering method for reducing blocking effects of a decompressed digital image, said signal adaptive filtering method comprising the steps of :

(a) generating binary edge map information by globally thresholding and locally thresholding the decompressed image;

(b) judging whether the binary edge map information within a filter window corresponding to respective pixels is either homogeneous area or edge area, by using the binary edge map information belonging to a predetermined size of the filter window;

(c) generating a filtered pixel value corresponding to a respective pixel using the filter window which has a predetermined first weight factors relating to the homogeneous area, when the binary edge map information is judged as the homogeneous area in the said step (b);

(d) altering the predetermined second weight factors according to a binary edge map information included in the filter window or corresponding to the respective pixel when the binary edge map information is judged as the edge area in the said step (b); and

(e) generating a filtered pixel value corresponding to the respective pixel, using the filter window which has altered second weight factors in said step (d).

According to the present invention in a second aspect, there is provided a filtering method comprising the steps of generating a filtered pixel value using a filter window weighted according to whether the filter window corresponds to an edge area.

Further features of the present invention are set out in the claims appended hereto.

The preferred embodiments of the present invention are described, by way of example only, with reference to the drawings that follow; wherein:

Figure 1 is a block diagram showing a signal adaptive postprocessing apparatus for reducing blocking effects and ringing noise according to a preferred embodiment of the present invention;

Figure 2A shows a filter window for a 5x5 filter proposed in the present invention;

Figure 2B shows the weight factors for the 5x5 average filter;

Figure 2C shows the weight factors for the 5x5 weighted filter;

Figure 3 shows the binary edge map produced in the binary edge mapper of Figure 1;

Figure 4A shows a filter window for a 3x3 filter proposed in the present invention;

Figure 4B shows the weight factors for the 3x3 average filter; and

Figure 4C shows the weight factors for the 3x3 weighted filter.

A preferred embodiment of the present invention will be described below in more detail with reference to the accompanying drawings :-

In Figure 1, a signal adaptive postprocessing apparatus according to a preferred embodiment of the present invention includes an image store 10, an image edge mapper portion 100 and a signal adaptive filter portion 200. The image store 10 stores decompressed image data, in more detail, data obtained by performing an inverse processing of a source encoding process including motion estimation and discrete cosine transform. The binary edge mapper portion 100 includes a gradient image generator 20, a global edge mapper 30, a local edge mapper 40 and a logic sum unit 50, which generates binary edge map information on which global edges and local edges of a decompressed image are reflected. The signal adaptive filter portion 200 includes a filter determiner 60, an average filter 70, and a weighted filter 80, which filters the decompressed image data using one of the average filter and the weighted filter to be described below based on the binary edge map information. The grid noise and the staircase noise is mitigated in the signal adaptive filter portion 200. The apparatus of Figure 1 further comprises an edge enhancement filter 90 for enhancing the edge information of the signal-adaptive-filtered image and reducing the staircase noise.

The gradient image generator 20 generates gradient image data using the image data stored in the image store 10. The gradient image generator 20 applies a vertical Sobel gradient operator and a horizontal Sobel gradient operator to the decompressed image, that is, the image data stored in the image store 10, to generate a gradient image. The gradient image data obtained by the gradient image generator 20 is supplied to the global edge mapper 30 and the local edge mapper 40.

The global edge mapper 30 produces a global edge map with respect to the whole image, and the local edge mapper 40 divides the whole image into blocks having a respectively predetermined magnitude and produces a local edge map with respect to each block. In more detail, the global edge mapper 20 calculates an edge value corresponding to each pixel using the following equation (1).

$$\text{If } |\nabla_h| + |\nabla_v| \geq T_g,\ \text{edge}(i,j)=1 \qquad (1)$$

$$\text{Otherwise,} \qquad \text{edge}(i,j)=0$$

Here ∇_h and ∇_v represent a horizontal gradient image and a vertical gradient image at location (i,j) obtained by the horizontal Sobel gradient operator and the vertical Sobel gradient operator, respectively. $|\nabla_h| + |\nabla_v|$ represents a gradient value at location (i,j), and T_g is a global threshold value which is 100 when each pixel of an image has 256 gray levels. Therefore, if a gradient value corresponding to a pixel is larger than or equal to the global threshold value T_g the global edge mapper 30 determines an edge value corresponding to the pixel as "1". On the other hand, if a gradient value corresponding to a pixel is smaller than the global threshold value T_g, the global edge mapper 30 determines an edge value corresponding to the pixel as "0". The global edge map information obtained by applying the above equation to the whole image is supplied to the logic sum unit 50.

The local edge mapper 40 produces a local edge map using the output of the gradient image generator 20. The local edge mapper 40 calculates a local threshold value with respect to each of all M_1 X M_2 blocks of the gradient image, and calculates local edge values with respect to all gradient values contained in corresponding block using the calculated local threshold value. According to the MPEG standard, the block-based processing techniques such as DCT transform and quantization process signals with respect to an 8x8 block containing basically 8x8 pixels. Thus, the local edge mapper 40 according to one embodiment of the present invention is also designed to draw a local edge map by using an 8x8 block. However, it will be apparent to a person skilled in the art that the present invention is not limited to the block of such a size.

The local threshold value T_n with respect to an n-th 8x8 block in the gradient image is defined by the following equations (2)-(4).

$$T_n = |1-\frac{\sigma_n}{m_n}| \times T_g \qquad (2)$$

wherein,

$$\sigma_N = \sqrt{\frac{1}{N} \sum_{(i,j)\in R_n} g(i,j)-m_n{}^2} \qquad (4)$$

$$m_n=\frac{1}{N}\sum_{(i,j)\in R_n} g(i,j)$$

Here, g(i,j) represents a gradient value, R_n represents an n-th 8x8 block region m_n and σ_n represent a mean value and a standard deviation of an n-th 8x8 block of the gradient image, respectively. T_g represents a global threshold value and N is 64 in the case of an 8x8 block. If the n-th 8x8 block is homogeneous, a ratio σ_n/m_n tends to be "0", with the result that T_n becomes very close to T_g. Meanwhile, if the n-th 8x8 block is part of a complicated image, the ratio σ_n/m_n increases. As a result, T_n becomes smaller than T_g. This small T_n is used in drawing a detail edge map which is not classified as a global edge by T_g, so that a local edge map can be calculated by T_n.

The local edge mapper 40 individually compares the local threshold value T_n with respect to the n-th 8x8 block with a part of the gradient values within the block, in magnitude. Here, the part of the gradient values corresponds to the 6x6 pixels within the 8x8 block excluding the boundary pixels within the 8x8 block. If the gradient value used for drawing the local edge map is defined as described above, the detailed information is protected from blurring and the grid noise is prevented from being detected as an image edge.

If each gradient value allowable within the n-th 8x8 block region R_n is larger than or equal to the local threshold value T_n, the local edge mapper 40 determines a local edge value corresponding to the gradient value as "1". Meanwhile, if a gradient value corresponding to a pixel is smaller than the local threshold value T_n, the local edge mapper 40 determines a local edge value corresponding to the gradient value as "0". The local edge mapper 40 generates local edge map information by performing a processing procedure for an 8x8 block division, local edge value calculation, and calculating a local edge value using allowable gradient values of each block, with respect to all gradient values generated by the gradient image generator 20. The generated local edge map information is supplied to the logic sum unit 50.

The logical OR unit 50 performs logical OR operation of the global edge map information and the local edge map information which are related each other with respect to a pixel location. The logical OR unit 50 performs a logical OR operation with respect to all global edge values on the global edge map and all local edge values on the local edge map, and outputs binary edge map information representing the result to the filter determiner 60. The binary edge map produced by the logical OR unit 50 is conceptually shown in Figure 3.

The filter determiner 60 stores the binary edge map information supplied from the logical OR unit 50. The decompressed image is classified into two areas such as an edge area and a homogeneous area by a binary edge map. For this classification, the present invention uses the filter determiner 60. The filter determiner 60 judges whether a region on the binary edge map where the filter window is located is an edge area or a homogeneous area, based on the edge values contained in the filter window having a predetermined magnitude. If it is judged as a homogeneous area, the filter determiner 60 outputs position data with respect to the central point in the filter window used for judgement, to the average filter 70. For the case in which it is judged as an edge area, the filter determiner 60 outputs the binary edge map information and position data with respect to the central point in the filter window used for judgement, to the weighted filter 80. Here, the central point represents a point where the pixel value of the point is replaced by a new value.

The average filter 70 and the weighted filter 80 according to the embodiments of the present invention use a 5x5 filter window or a 3x3 filter window, respectively. Therefore, the filter window used in the filter determiner 60 has also a 3x3 or 5x5 size. The average filter 70 and the weighted filter 80 are two-dimensional low-pass filters, which will be described below, assuming that the filters 70 and 80 are designed to match a 5x5 filter window as an example.

Figures 2A to 2C show the filter window and the weight factors for a 5x5 filter. Figure 2A shows a filter window for a 5x5 filter. In Figure 2A, the numerical figures represent filter coefficient (or weight) indices, in which a point where the filter coefficient index value is "11" represents the central point of the filter window. Figures 2B and 2C show the weight factors when the 5x5 filter window is used. Figure 2B shows the weight factors for the 5x5 average filter. Figure 2C shows the weight factors for the 5x5 weighted filter. It is allowable that the weight factor of "3" at the central point shown in Figure 2C is replaced by 4. The arrow lines of Figure 2A are used for determining outer neighbouring points concerning a particular edge point. Here, the edge point is a point where the edge value is "1" which is represented as shaded rectangles on the binary edge map of Figure 3.

If position data with respect to the central point is input, the average filter 70 reads the pixel values necessary to calculate the filtered pixel value of the central point from the image store 10. Then, the average filter 70 calculates the filtered pixel values using the read pixel values and the weight factors shown in Figure 2B. The calculated filtered pixel value is used as an altered pixel value with respect to the central point. The weighted filter 80 performs a filtering operation based on the binary edge map information supplied from the filter determiner 60 and the position data with respect to the central point. The operation of the weighted filter 80 will be described below in more detail.

If the central point "11" of the filter window shown in Figure 2A is an edge point, the weighted filter 80 does not perform a filtering operation for the central point. If the edge point or the edge points are positioned in the 5x5 filter window excluding the central point, the weighted filter 80 performs a filtering operation using the weight factors shown in Figure

2C. The weight factors are varied according to the positions of the edge point in the filter window to protect details of the image. If any edge is on the points 12, 7, 6, 5, 10, 15, 16 or 17 of Figure 2A, the weight factors of the edge pixel and the outer neighbour pixels are set to zero. For example, if the point 12 is an edge pixel, the points 12, 8, 13 and 18 will be outer neighbours points whose weight factors are set to zero. If the point 7 is an edge pixel, the points 7, 3 and 8 will be outer neighbour points and will be zero.

The average filter 70 and the weighted filter 80 are described below designed to be appropriate for a 3x3 filter window.

Figures 4A to 4C show the filter window and the weight factors for a 3x3 filter. Figure 4A shows a filter window for a 3x3 filter. Figure 4B shows the weight factors for the 3x3 average filter. Figure 4C shows the weight factors for the 3x3 weighted filter. It is allowable that the weight factor of "3" at the central point shown in Figure 4C is replaced by 2. In Figure 4A, a point where the filter weighted index value is "5" represents the central point of the filter window. The average filter 70 performs the same operation as the case using the 5x5 filter window having the filter weight factors shown in Figure 4B. An explanation of the operation of the average filter 70 in the case in which the 3x3 filter window is used will be omitted, since one skilled in the art can understand it well with reference to the above-described 5x5 average filter.

If the central point "5" of the filter window shown in Figure 4A is an edge point, the weighted filter 80 does not perform a filtering operation for the central point. If the edge point or the edge points are positioned in the 3x3 filter window excluding the central point, the weighted filter 80 performs a filtering operation using the weight factors shown in Figure 4C. If any edge is on the points 2 and 6, 6 and 8, 4 and 8, or 2 and 4 of Figure 4A, the weight factors of the edge pixel and the outer neighbour pixels are set to zero.

The signal adaptive filtered image data obtained by the average filter 70 and the weighted filter 80 are supplied to the image store 10. The image store 10 replaces a corresponding pixel value by the image data supplied from the average filter 70 and the weighted filter 80. If the image store 10 replaces the decompressed image data by the signal adaptive filtered image data with respect to all pixels, an image which is displayed by using the image data stored in the image store 10 has a quality of image from which blocking effects and ringing noise are remarkably reduced.

With respect to CLASS-A and CLASS-B which are using as the text sequences of MPEG-4 and H.263+, in case of a sequence of CLASS-A, a desired quality of image can be obtained by performing only a signal adaptive filtering with respect to the binary edge map information. However, in the case of a sequence of CLASS-B, a more desired quality of image can be obtained by performing an edge enhancement filtering with respect to the signal adaptive filtered image.

The edge enhancement filter 90 according to the embodiment of the present invention described herein is designed as a one-dimensional three-tap filter whose weight factor is (1,4,1). If the signal adaptive filtered signal produced by the average filter 70 and the weighted filter 80 is applied, the edge enhancement filter 90 determines the direction of the edge as one of the 45 °, 135 °, 90 ° and 0 ° from the signal adaptive filtered image. For such determination, the edge enhancement filter 90 uses the binary edge map information stored in the filter determiner 60. The edge enhancement filter 90 performs a one-dimensional filtering by using the filter weight factors with respect to all edge points of the signal adaptive filtered image whose direction has been determined. The edge information is reinforced and the staircase noise is reduced by the edge enhancement filter 90. The filtered image data in the edge enhancement filter 90 is supplied to the image store 10. The image store 10 performs the same operation as the image data supplied from the average filter 70 and the weighted filter 80. Thus, when the edge enhancement filter is additionally used, the blocking effects are reduced and the edge enhanced image can be provided to viewers.

The CLASS-A and CLASS-B sequences which are encoded and decoded in H.263 are used for evaluating the postprocessing system proposed in the present invention. The 3x3 signal adaptive filter is applied to the CLASS-A sequence which is encoded and decoded in H.263, while the 3x3 signal adaptive filter and the 5x5 signal adaptive filter are applied to the CLASS-B sequence. In the CLASS-B sequence, the 3x3 filtered image has a higher peak signal to noise ratio (PSNR) than the 5x5 filtered image. However, the subjective quality of the 5x5 filtered image is better than the 3x3 filtered image. Therefore, the 5x5 signal adaptive filtering and the one-dimensional edge enhancement filtering are desirable to the image of the CLASS-B even though the PSNR is degraded somewhat. Tables 1 and 2 show the decompressed sequences and various postprocessing sequences. Table 1 below shows the test result of the CLASS-A sequences, in which (a) is the result of the 3x3 signal adaptive filter proposed in the present invention. Table 2 below shows the test result of the CLASS-B sequences, in which (a) is the result of the 3x3 signal adaptive filter, (b) is the result of the 5x5 signal adaptive filter and (c) is result of the 5x5 signal adaptive filter and the edge enhancement filter.

Table 1

Bit Rate Spatial Resolution Frame Rate	Sequence	H.263 (PSNR)	(a)
10kbps, QCIF, 5Hz	Akiyo	34.81	35.06
	Hall monitor	32.65	32.88
	Container ship	31.97	32.00
	Mother & daughter	33.81	33.93
24kbps, QCIF, 10Hz	Akiyo	36.18	36.25
	Hall monitor	33.68	33.88
	Container ship	33.36	33.32
	Mother & daughter	35.18	35.18

Table 2

Spatial Resolution Frame Rate	Bit Rate	Sequence	H.263 (PSNR)	(a)	(b)	(c)
CIF, 7.5Hz	48kbps	News	32.00	32.13	32.06	31.97
	77kbps	Foreman	29.46	29.53	29.54	29.53
	70kbps	Coastguard	26.35	26.35	26.31	26.27
	48kbps	Silent voice	31.55	31.55	31.47	31.46
CIF 15Hz	112kbps	News	34.42	34.59	34.46	34.27
	112kbps	Foreman	30.06	30.12	30.12	30.07
	114kbps	Coastguard	26.71	26.71	26.68	26.62
	112kbps	Silent voice	32.89	33.04	32.90	32.83

As described above, the system according to the described embodiment of the present invention improves a quality of the block-based decompressed image. The described embodiment of the present invention uses signal adaptive filtering to reduce blocking effects without degradation of the image details. The signal adaptive filtering is based on the edge information generated by a gradient calculation and an adaptive threshold scheme. The objective performance is measured by the PSNR. The measured PSNR shows a small increase in CLASS-A and CLASS-B sequences when the 3x3 signal adaptive filter is adopted. However, the PSNR does not fully reflect the enhancement of the image quality in the psychovisual viewpoint. Even though the small fraction of the PSNR is improved, a definite improvement in subjective quality can be observed. Therefore, the postprocessing system proposed in the described embodiment of the present invention effectively reduces the blocking effects and the ringing noise, and well preserves and enhances block-based decoded images without any increase in the bitrates.

While only certain embodiments of the invention have been specifically described herein, it will be apparent that numerous modifications may be made thereto without departing from the spirit and scope of the invention.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and th contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be

replaced by alternative features serving the same, equivalent or similar purpose, unless expr ssly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A signal adaptive filtering method for reducing blocking effects and ringing noise of a decompressed digital image, said signal adaptive filtering method comprising the steps of

   (a) generating binary edge map information by globally thresholding and locally thresholding the decompressed image;
   (b) judging whether the binary edge map information within a filter window corresponding to respective pixels is either homogeneous area or edge area, by using the binary edge map information belonging to a predetermined size of the filter window;
   (c) generating a filtered pixel value corresponding to a respective pixel using the filter window which has a predetermined first weight factors relating to the homogeneous area, when the binary edge map information is judged as the homogeneous area in said step (b);
   (d) altering the predetermined second weight factors according to a binary edge map information corresponding to the respective pixel when the binary edge map information is judged as the edge area in said step (b); and
   (e) generating a filtered pixel value corresponding to the respective pixel, using the filter window which has altered second weight factors in said step (d).

2. A signal adaptive filtering method according to claim 1, wherein said step (a) comprises the steps of :

   (a1) generating a gradient image corresponding to the decompressed image;

   (a2) generating global edge map information which is composed of edge values corresponding to the respective pixels of the decompressed image, by comparing a predetermined first thresholding value with a gradient value corresponding to the respective pixels within the gradient image;

   (a3) generating local edge map information which is composed of edge values corresponding to the respective pixels of the decompressed image, by comparing gradient values within a predetermined size of individual blocks into which the decompressed image is divided, with a predetermined second thresholding value corresponding to the block; and

   (a4) logically summing an edge value in the global edge map information and a corresponding edge value in the local edge map information, and generating binary edge map information.

3. A signal adaptive filtering method according to claim 1 or claim 2, wherein said step (a3) calculates the second thresholding value corresponding to respective blocks using the following equation :

$$T_n = |1 - \frac{\sigma_n}{m_n}| \times T_g \qquad (2)$$

wherein,

$$\sigma_N = \sqrt{\frac{1}{N} \sum_{(i,j) \in R_n} g(i,j) - m_n^{\ 2}} \qquad (4)$$

$$m_n = \frac{1}{N} \sum_{(i,j) \in R_n} g(i,j)$$

Here, g(i,j) represents a gradient value, R_n represents an n-th 8x8 block region, m_n and σ_n represent an average deviation and a standard deviation of an n-th 8x8 block of the gradient image, and T_g represents a global threshold value.

4. A signal adaptive filtering method according to claim 3, therein said step (a3) compares the gradient values corresponding to 6x6 pixels within a 8x8 block excluding boundary pixels within the 8x8 block with the corresponding second thresholding value.

5. A signal adaptive filtering method according to any preceding claim, wherein the more said predetermined second weight factors move from the centre of the filter window to the boundary thereof, the less said predetermined second weight factors have.

6. A signal adaptive filtering method according to claim 5, wherein said filter window has a 5x5 size.

7. A signal adaptive filtering method according to claim 6, wherein said step (c) uses a filter window in which first weight factors positioned at four corners are "0" in magnitude, and those positioned at the remaining points are "1".

8. A signal adaptive filtering method according to claim 6, wherein a second weight factor located in the centre of the said filter window is "3" in magnitude, and second weight factors located at the others thereof are less than "2", wherein the closer the second weight factors are to boundary of the filter window, the less the second weight factors become.

9. A signal adaptive filtering method according to claim 6, wherein a second weight factor located in the centre of said filter window is "4" in magnitude, and second weight factors located at the others thereof are less than "2", wherein the closer the second weight factors are to edge points of the filter window, the less the second weight factors become.

10. A signal adaptive filtering method according to any one of claims 1-5, wherein said step (d) comprises the step of changing, to zero, the second weight factors which are located at the edge point and outer neighbouring points of the edge point, based on the edge point within the filter window.

11. A signal adaptive filtering method according to any one of claims 1-5, wherein said filter window has a 3x3 size.

12. A signal adaptive filtering method according to claim 11, wherein said step (c) uses the filter window having the same magnitude of first weight factors.

13. A signal adaptive filtering method according to claim 12, wherein said first weight factor is "1".

14. A signal adaptive filtering method according to claim 11, wherein a second weight factor located in the center of said filter window is "2" in magnitude, and second weight factors located at the others thereof are "1".

15. A signal adaptive filtering method according to claim 11, wherein a second weight factor located in the centre of said filter window is "3" in magnitude, and second weight factors located at the others thereof are "1".

16. A signal adaptive filtering method according to claim 11, wherein said step (d) comprises the step of resetting, as zero, second weight factors corresponding to positions put on a diagonal line and second weight factors corresponding to the outer neighbour of positions placed on the diagonal line, if the binary edge map information which corresponds to positions on the diagonal lines among the positions excluding the central points of the 3x3 filter window is represented as all edge points.

17. A signal adaptive filtering method according to any preceding claim, wherein said step (e) performs no filtering operation with regard to corresponding pixels if the central point within said filter window is an edge point.

18. A filtering method comprising the steps of generating a filtered pixel value using a filter window weighted according

to whether the filter window corresponds to an edge area.

19. A filtering method according to claim 18, which method further comprises any one or more f ature or step disclosed in the accompanying description, claims, abstract and/or drawings, in any combination.

20. A filtering apparatus adapted to operate according to any preceding claim.

FIG. 1

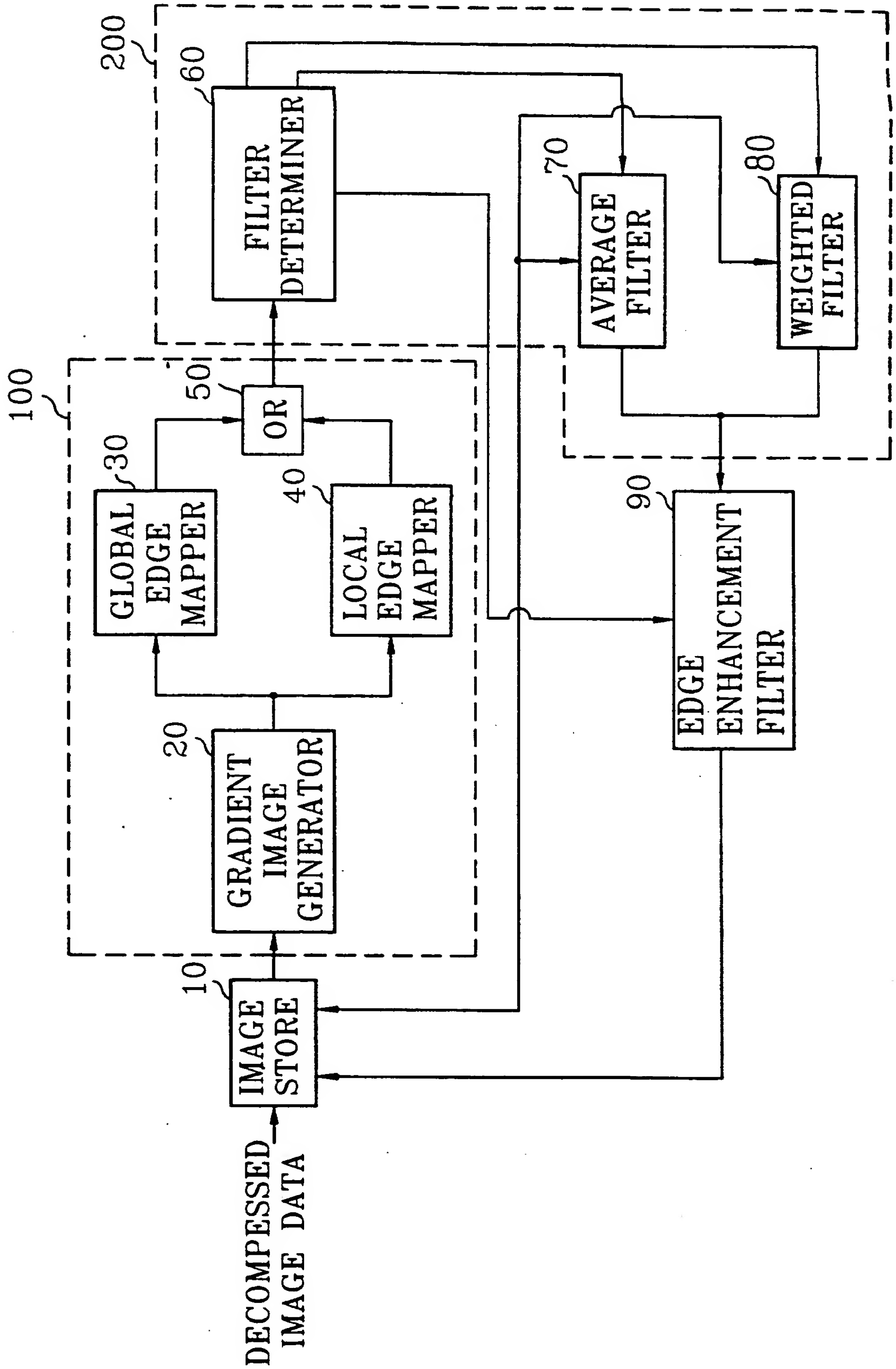

DECOMPRESSED IMAGE DATA
IMAGE STORE
10
100
GRADIENT IMAGE GENERATOR
20
GLOBAL EDGE MAPPER
30
LOCAL EDGE MAPPER
40
OR
50
200
FILTER DETERMINER
60
AVERAGE FILTER
70
WEIGHTED FILTER
80
EDGE ENHANCEMENT FILTER
90

FIG. 2A

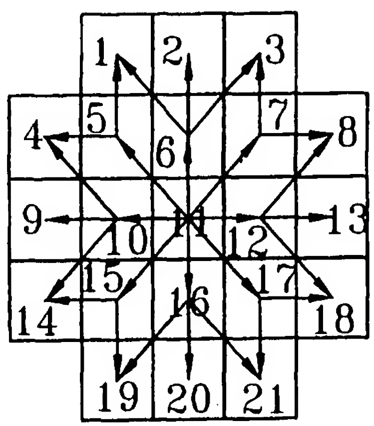


FIG. 2B

0	1	1	1	0
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
0	1	1	1	0

FIG. 2C

0	1	1	1	0
1	1	2	1	1
1	2	3	2	1
1	1	2	1	1
0	1	1	1	0

FIG. 3

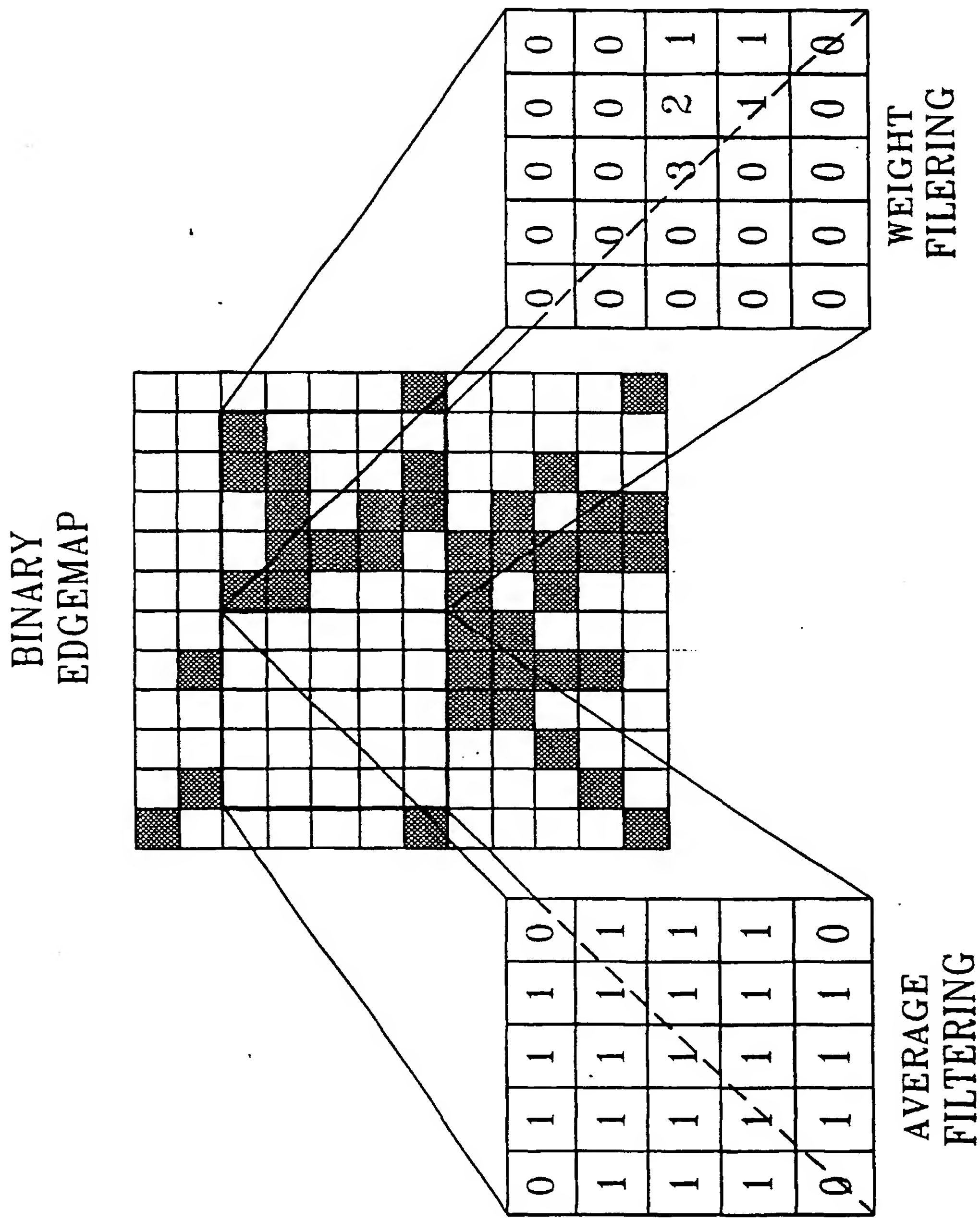


FIG. 4A

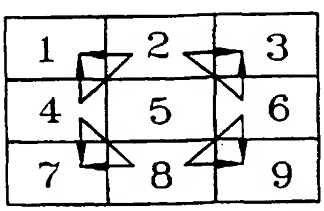


FIG. 4B

1	1	1
1	1	1
1	1	1

FIG. 4C

1	1	1
1	3	1
1	1	1